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Evaluation of nutrient composition and organoleptic properties of cookies produced from composite flours of sorghum, black bean and cocoyam

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Abstract
The proximate and mineral composition as well as the sensory properties of cookies produced from composite flours of sorghum, black bean and cocoyam were investigated. The blends of sorghum, black bean and cocoyam flour (80: 15:5, 70:20:10, 60:25:15 and 50:30:20) were used in the preparation of composite cookies with 100% wheat flour cookies as control. The proximate, mineral and sensory properties of the samples were determined using standard methods of analysis. The moisture, crude protein, fat, ash and crude fibre contents of the cookies increased significantly (p<0.05) with increase in substitution with black bean and cocoyam flours from 8. 11±0.07 – 9.30±0.28%, 9.07±0.21 -12.10±0.35%, 2.52±0.05 – 4.49±0.77%, 3.90±0.08 – 5.11 ±0.04% and 3.21 ±0.07 – 4.72±0.05%, respectively, while the carbohydrate decreased. The control (wheat flour cookies) and the cookie samples substituted with 30% black bean and 20% cocoyam flours had the highest (73.19±0.27%) and the least (64.80±0.42%) carbohydrate contents, respectively. The mineral content of the cookies showed that the calcium, phosphorus, magnesium, potassium and iron contents of the samples increased significantly (p<0.05) with increase in the levels of substitution with black bean and cocoyam flours from 18.7±0.73 – 28.8±0.54mg/100g, 69.5±1.83 – 90.1±1.45mg/100g, 34.2±0.09 – 40. 1±0.42mg/100g, 33.4±1.07 – 39.3±0.48mg/100g and 25.5±1.12-30.1±0.39mg/100g, respectively. The sensory properties of the samples also revealed that the cookies produced from 100% wheat flour used as control were the most acceptable to the panelists and also differed significantly (p<0.05) from composite cookie samples in colour, taste, texture and flavour. Although, the 100% wheat flour cookies had better consumers' sensory attributes, all the composite cookie samples had higher nutrient contents with the exception of carbohydrate than the wheat flour cookies. The study, therefore, showed that the macro and micronutrient contents of cookies can be improved by supplementing sorghum flour with black bean and cocoyam flours at different graded levels, thus providing good alternatives for the use of non-wheat flours in the preparation of cookies.

Keywords: Cookies, sorghum flour, black bean flour, cocoyam flour, proximate composition, micronutrient, sensory properties

Introduction

The problems of malnutrition in Nigeria and other developing countries of the world, although different in magnitude and severity among different groups, are mainly due to deficiencies in protein, energy, vitamins and minerals (Arshad *et al.*, 2007; Okpala *et al.*, 2013) [3, 26]. Since the diet of an average Nigerian consists of foods that are mostly carbohydrate based, there is therefore need for strategic use of inexpensive high protein and micronutrient rich food sources that will improve the nutritional and health status of the dwellers. Recently, the focus of interest has been in the development of food products from by-products or wastes and under-utilized agricultural products "wealth from waste" (Sharma and Chauhan, 2002) [31]. Apparently, such utilization and development on the production of new food products with available resources to contribute to the recommended dietary intake is the thrust of this work.

Cookies (soft type biscuits) are one of the important snacks that are consumed in many developed and developing countries of the world (Chinma and Gernah, 2007) [7]. The consumption of cookies and other baked products such as cakes, breads, biscuits and pie crust is increasing steadily in Nigeria due to changes in the life styles of some people. Nutritionally, cookies contain high percentage of carbohydrate and fat both of which are needed for energy production. Other nutrients like vitamins, minerals and protein are small in proportion (Young, 2001; Atuonwu and Akobundu, 2010) [34, 1]. They are however, relatively expensive, being made from wheat which cannot be cultivated in the tropics for climatic reasons. The development of new generation cookie products derived from diverse sources of non –wheat flours provides an alternative towards nutritionally superior and cheaper cookie products (Hallen *et al.*, 2004) [14]. The formulation of composite flour is vital for the development of value added products with optimal functionality. A variety of wheat flour substitutes such as African walnut flour (Barber and Obinna –Echem, 2016), African bread fruit flour (Okoye and Obi, 2017) [24], soy or defatted soy flour (Okoye *et al.*, 2016) [25] and pigeon pea flour (Okpala *et al.*, 2013) [26] have been tried in the formulation of bakery products with varying degrees of success.

Sorghum (*Sorghum bicolor*), black bean (*Phaseous vulgaris*) and cocoyam (*Colocasia esculenta*) are the cheapest and nutrient dense food crops that are readily available in Nigeria. They have promising nutritional attributes. Whole sorghum grain is an important source of vitamins and some minerals like calcium, phosphorus, magnesium, potassium and iron (Onabanjo *et al.*, 2009) [29]. The protein content of sorghum is similar to that of wheat and maize, with lysine as the most limiting essential amino acid (FAO, 2009) [11]. Sorghum contains high level of dietary fibre (13.2%) but low in trace minerals and ascorbic acid. Black bean is a legume that contains better quality protein than the most of the under-utilized legumes. It is also rich in vitamins and minerals (Audu and Aremu, 2011) [4]. Cocoyam is a staple food for millions of people living in tropical regions of developing countries of the world (Nwanekezi *et al.*, 2010) [23]. Nutritionally, cocoyam corms or cormels contain easily digestible starch and dietary fibre. They are also known to contain substantial amounts of minerals and vitamins (FAO, 1990; Singh *et al.*, 2008) [10, 32]. However, the supplementation of sorghum flour with blackbean and cocoyam flours in the production of cookies has the potential to uplift the nutritional value of the products with special reference to protein, mineral, vitamin and dietary fibre contents. Therefore, the major thrust of the study is to develop and evaluate the nutrient composition and sensory properties of cookies produced from sorghum, blackbean and cocoyam composite flours.

Materials and Methods

The white variety of sorghum (*Sorghum vulgare*), black bean (*Phaseous vulgaris*) and cocoyam (*Colocasia esulenta*) used for the study were purchased from New Market, Enugu, Enugu State, Nigeria. Commercial wheat flour and other ingredients (fat, sugar (sucrose), baking powder, salt, eggs and flavouring (vanilla flavour) used for the production of cookies were also bought from the same market.

Preparation of malted sorghum flour

The malted sorghum flour was prepared according to the method of Elemo *et al.* (2011) [9]. One kilogramme (1kg) of sorghum grains were sorted to remove dirt and other extraneous materials. The sorted grains were thoroughly cleaned and steeped in 3.5 litres of potable water in a plastic bowl at room temperature (30 ± 2^0C) for 20 h with a change of water at every 5 h to prevent fermentation. The steeped grains were drained, rinsed and immersed in 2% sodium hypochlorite solution for 10 min to sterilize the grains. The grains were rinsed for five consecutive times with excess water and cast on a damped jute bag, covered with a polyethylene bag and left for 24 h to fasten sprouting. The grains were carefully spread on the jute bag and allowed to germinate in the germinating chamber at ambient temperature (30 ± 2^0C) and relative humidity of 95% for 96 h. During this period, the grains were sprinkled with water at intervals of 12 h to facilitate germination. Non-germinated grains were handpicked and discarded. The germinated grains were spread on the trays and dried in a tray dryer (Model EU 8500, UK) at 50^0C for 24 h with occasional stirring of the grains at intervals of 30 min to ensure uniform drying. The dried malted grains were cleaned, rubbed in-between palms and winnowed to remove the roots and the sprouts. The sorghum malts were milled in a hammer mill and sieved through a 400 micron mesh sieve. The flour produced was packaged in a sealed plastic container, labeled and stored in a freezer until needed for further use.

Preparation of Malted Black Bean Flour

The malted blackbean flour was prepared according to the method of Oladele *et al.* (2009) [28] with slight modifications. One kilogramme (1kg) of blackbean seeds were sorted to remove dirt and other contaminants. The sorted seeds were thoroughly cleaned and steeped in 3 litres of potable water in a plastic bowl at room temperature (30 ± 2^0C) for 18 h with a change of water at every 6 h to prevent fermentation. The steeped seeds were drained, rinsed and immersed in 2% sodium hypochlorite solution for 10 min to sterilize the seeds. The seeds were rinsed for five consecutive times with excess water and cast on a damped jute bag, covered with a polyethylene bag and left for 24 h to fasten sprouting. The seeds were carefully spread on the jute bag and allowed to germinate in the germinating chamber at ambient temperature (30 ± 2^0C) and relative humidity of 95% for 96 h. During this period, the seeds were sprinkled with water at intervals of 12 h to facilitate germination. Non-germinated seeds were handpicked and discarded. The germinated seeds were spread on the trays and dried in a tray dryer (Model EU850D, UK) at 60^0C for 18 h with occasional stirring of the seeds at intervals of 30 min to ensure uniform drying. The dried malted seeds were cleaned, rubbed in-between palms and winnowed to remove the roots and the sprouts along with the hulls. The dehulled malted seeds were milled in a hammer mill and sieved through a 400 micron mesh sieve. The flour produced was packaged in a lidded container, labeled and stored in a freezer until needed for further use.

Preparation of cooked cocoyam flour

The cooked cocoyam flour was prepared according to the method of Igbabul *et al.* (2014) [17] with slight modifications. One kilogramme (1kg) of freshly harvested cocoyam corms were thoroughly cleaned with 3.5 litres of potable water and peeled manually with kitchen knife. The peeled cocoyam corms were cut into small slices of uniform shape. The cocoyam slices were rinsed, placed into a stainless pot and blanched with 2.5 litres of potable water at 85^0C for 20 min on a hot plate. The blanched cocoyam slices were drained, rinsed, spread on the trays and dried in a tray dryer (Model EU850D, UK) at 60^0C for 16 h with occasional stirring of the slices at intervals of 30min to ensure uniform drying. The dried cocoyam slices were milled in a hammer mill and sieved through a 400 micron mesh sieve. The flour produced was packaged in a lidded plastic container, labeled and stored in a freezer until needed for further use.

Formulation of flour blends

Sorghum, blackbean and cocoyam flours were blended together at varying graded proportions of 80: 15: 5, 70: 20: 10, 60: 25: 15 and 50: 30: 20 in a Kenwood mixer (Mini-Processor, Model E80 CD, Kenwood Ltd, Havant, Hamphsire, UK) to produce composite flours. The composite flours produced were separately packaged in sealed plastic containers, labeled and stored in a freezer until needed for the preparation of cookies.

Preparation of cookies

The cookies were prepared according to the method of Okoye and Obi (2017) [24]. The recipe used for the preparation of the cookies contained 100% flour, 80% fat, 60% sugar (sucrose), 2% baking powder, 2% salt, 5% beaten egg and 5mL vanilla flavour. The sugar, flour, baking powder and salt were mixed in a plastic bowl. The fat was added and the mixture was mixed further by hand until a bread crumb-like mixture was obtained. The mixture was transferred into the food processor (Homeluck). The liquid beaten egg and vanilla flavour were added and the mixture was thoroughly mixed at medium speed for 5 min to obtain the dough. The dough was manually rolled out on a flat and smooth floured board into sheets of uniform thickness of 4cm and cut with a circular cookie cutter with diameter of 4cm. The cut dough pieces were placed separately into the baking trays greased with vegetable oil, lined with grease-proof paper and baked in an electric oven (Salva, USA) at 180^0C for 15 min. The cookies were removed from the oven, taken out of the baking trays and allowed to cool at ambient temperature (30$\pm$ 2^0C) for 40 min. The cooled cookies were separately divided into two (2) lots. The first lot was wrapped in aluminum foil, kept in a plastic container and used for sensory evaluation after 24 h. The second lot was packaged in sealed plastic container, stored at room temperature until needed for analysis. The cookies prepared from 100% wheat flour were used as control.

Proximate analysis
The moisture, protein, fat, ash, crude fibre and carbohydrate contents of the cookies were determined using standard analytical methods (AOAC, 2006) [2]. Moisture content was determined by drying 5g of the milled cookies at 130^0C for 1h in an air oven (Sanyo Gallenkamp, Weiss Technik, West Midlands, UK). Ash was determined gravimetrically in a muffle furnace (Sanyo Gallenkamp, Weiss Technik, West Midlands, UK) at 550^0C for 22 h. Protein was determined by Kjeldahl method. After distillation and titration, the nitrogen was corrected using a factor of 6.25. Fat was determined by exhaustive extraction of 1g of the sample with petroleum either in a rapid Soxhlet extraction unit (Gerhardt, Bonn, Germany). Crude fibre was obtained by difference after the incineration of the ash-less filter paper containing the insoluble materials from the hydrolysis and washing of moisture –free defatted sample (1g). Carbohydrate was determined by difference on dry sample weight by subtracting the summation of the percentage moisture, crude fibre, fat, ash and protein contents from 100%.

Mineral Analysis
The minerals were extracted by dry –ashing of the cookie samples at 550^0C to constant weight followed by the dissolution of the ash in volumetric flask by the addition of 50mL of de-ionized water and a few drops of concentrated hydrochloric acid. The calcium, phosphorus, potassium, magnesium and iron contents of the samples were evaluated using atomic absorption spectrophotometer (Pertin – Elmer, 2380, Germany) according to the standard methods of AOAC (2006) [2].

Sensory Evaluation
The wheat and composite flour cookies were evaluated by twenty (20) semi – trained consumer taste panelists consisting of students and staff of the Department of Food Science and Technology, Enugu State University of Science and Technology, Enugu, Nigeria. The panelists were carefully selected and used for the sensory test. The samples were evaluated for the attributes of colour, taste, flavour, texture and overall acceptability using a nine- point Hedonic scale with 1 and 9 representing dislike extremely and like extremely, respectively (Iwe, 2007) [19]. The sensory evaluation was carried out in the Food Research Laboratory of the Department of Food Science and Technology, Enugu State University of Science and Technology, Enugu, Nigeria. The panelists were sitted in such a way that they could not see the rating of each other. The samples were randomly coded and served in plain coloured plastic plates and each panelist was provided with a cup of drinking water to rinse his or her mouth after testing each sample to avoid residual effect. The panelists were asked to evaluate and rate each sample of the cookies based on their level of preference and acceptance of the product.

Statistical analysis
The data generated were subjected to one-way analysis of variance (ANOVA) using SPSS, version 16.0 software (SPSS, Inc, Chicago, USA). Means were separated using Duncan's New Multiple Range Test (DNMRT) at $p<0.05$ and the results were expressed as mean $\pm$ standard deviation of triplicate determinations.

Results and discussion
Proximate Composition of Cookies
The proximate composition of cookie samples are shown in Table 1. The moisture content of the cookies increased significantly ($p<0.05$) with increased levels of supplementation of blackbean and cocoyam flours. The levels of blackbean and cocoyam flours in the cookies are correlated with the moisture content. The increase in the levels of the flours (blackbean and cocoyam) in the samples increased the moisture content. This might be attributed to the higher water absorption capacity of the composite flour compared to the wheat flour which is in agreement with the report of Barber and Obinna –Echem (2016) for wheat –African walnut cookies. According to Wang *et al.* (2002) [33], the higher total fibre in the non-wheat flour interact relatively well with a large amount of water through the hydroxyl group in the fibre structure. The protein content of the composite cookies showed significantly ($p<0.05$) higher values than the wheat flour cookies (control) because the commercial wheat flour has low protein content (13.26%) than the blackbean flour (22.27%). Hence, the incorporation of blackbean flour in the cookies resulted in increase in the protein content of the samples. The observation is in agreement with the report of Okoye and Obi (2017) [24] for wheat-African bread fruit composite flour cookies. Protein in the diet helps primarily in building and maintenance of body cells. The fat content of the cookies increased as the proportion of blackbean flour increased. This is in line with the report that blackbeans have high oil content (Gary *et al.*, 1997) [13]. The oil extracted from blackbean seeds was reported to be an excellent source of Omega -3 essential fatty acids; a special type of protective fat the body cannot manufacture (Jose De *et al.*, 1999) [20]. Fat is important in the diet as it supplies the body with essential fatty acids, fat soluble vitamins and energy. The ash content of the composite cookies was significantly ($p<0.05$) higher than the control (100% wheat flour cookies).The increase could be due to substitution effect. The high ash content of the cookies is an indication that they are good sources of minerals (Okpala and Okoli, 2011) [27]. The crude fibre content of the samples ranged from 3.21 to 4.72%. The values (3.21-4.72%) obtained in this study were within the recommended FAO/WHO (1994) [12] level of not more than 5% for both children and adults. Crude fibre plays a significant role in the prevention of many diseases of the

digestive tract in human body. The carbohydrate content of all the composite cookies were significantly ($p<0.05$) lower than the control. The decrease could be attributed to the addition of higher proportion of blackbean flour which has a low carbohydrate content in the formulation. Ihediohanma *et al.* (2009) [18] reported a decrease in carbohydrate content of cakes with increase in substitution of African breadfruit flour. The substitution of sorghum–based cookies with blackbean and cocoyam flours drastically improved the protein, fat, ash and crude fibre contents of the composite cookies

Mineral composition of cookies

The mineral composition of the cookies are shown in Table 2. The levels of the minerals: calcium, phosphorus, magnesium, potassium and iron increased with increase in substitution. The increase in the mineral contents of the sorghum, blackbean and cocoyam composite cookies confirm the beneficial effect of supplementation (Lutter and Deway, 2003) [21]. The calcium content of the wheat flour cookies was the least (18.7mg/100g), while the sorghum flour cookies substituted with 30% blackbean and 20% cocoyam flours had the highest calcium content (28.8mg/100g). This showed that the addition of higher proportion of blackbean flour resulted in increase in calcium content of the samples. The observation is an indication that blackbeans are good sources of calcium (Hurs and Martins, 2005) [16]. Calcium is necessary for optimal growth and development in the body. The phosphorus content of the samples which ranged from 69.5 to 90.1 mg/100g increased significantly ($p<0.05$) as the proportion of blackbean flour increased. The values obtained in this study were higher than the phosphorus content (56.7 – 78.6mg/100g) reported by Chinma *et al.* (2012) [8] for cookies prepared from unripe plantain and defatted sesame flour blends. Phosphorus is an important constituent of every living cell. It is very essential in bone formation and other cellular reactions in the body (Berdanier and Zempleni, 2009) [6]. The magnesium content of the composite cookies was significantly ($p<0.05$) higher than the control (100% wheat flour cookies). The increase could be due to substitution effect caused by high level of magnesium in blackbean flour as reported by Gary *et al.* (1997) [13]. Magnesium is involved in over 300 metabolic reactions and is needed for bone formation, protein synthesis, production of new cells, activation of B-group vitamins, relaxation of nerves and muscles, blood clotting and in energy production (Horsfall *et al.,* 2007) [15]. The potassium content of the samples varied between 33.4 and 39.3mg/100g with the control and the sorghum flour cookies substituted with 30% blackbean and 20% cocoyam flours having the least (33.4mg/100g) and the highest (39.3mg/100g) values, respectively. The potassium content of the cookies was observed to increase as the level of black bean flour increased and this is in agreement with the report that blackbeans are good sources of potassium (Noor *et al.,* 2012) [22]. Potassium is very essential in bone formation and proper functioning of the muscles (Okaka *et al.,* 2006). The iron content of the cookies increased significantly ($p<0.05$) as the level of substitution with blackbean flour increased in the samples. The observed increase in the iron content of the composite flour cookies could be attributed to the substitution effect. Iron is very important in the formation of blood cells and prevention of anaemia in infants, young children and adults. The substitution of sorghum flour with blackbean and cocoyam flours in the preparation of cookies greatly improved the levels of minerals in the samples.

Sensory properties of cookies

The sensory properties of the cookies are shown in Table 3. The sensory properties of the cookies showed that there were significant differences ($p<0.05$) among the samples in taste, flavour, texture, colour and overall acceptability. Overall acceptability was determined on the basis of the scores obtained after the evaluation of taste, texture, flavour and colour. It was observed from the result that 100% wheat cookies were the most acceptable to the panelists followed by the sorghum flour cookies substituted with blackbean and cocoyam flours at different graded levels. This could be due to the fact that people have been used to the consumption of wheat flour cookies. The colour, taste and texture of the samples also decreased with increased substitution. The variation observed in the colour, could be due to increased substitution of blackbean and cocoyam flours and the addition of sugar which gave the composite flour cookies a slightly dark brown colouration compared to the control samples which were light- brown in colour. This condition could be attributed to Maillard browning caused by the reaction between the amino acids of the proteins and the added sugar (Onimawo and Akubor, 2005) [30] and caramelization which are influenced by the distribution of water and the reaction of added sugars and amino acids (Okpala *et al.,* 2013) [26]. Colour appeared to be a very important criterion for the initial acceptability of the baked product by the consumer. The substitution of sorghum flour cookies with blackbean and cocoyam flours at different graded levels produce good and acceptable results.

Conclusion

The study showed that nutritious and acceptable cookies could be produced from composite flours of sorghum, blackbean and cocoyam. Although, the 100% wheat flour cookies (control) were the most acceptable organoleptically, the composite cookies were nutritionally superior. The use of sorghum – blackbean – cocoyam composite flours in the production of cookies drastically improved the protein, fat, ash, crude fibre, calcium, phosphorus, potassium, iron and magnesium contents of the composite cookies compared to the control. With the cost of wheat flour in Nigeria and other developing countries of the tropics, it is better to properly explore the use of non-wheat flours for commercial production of cookies. This practice will help to increase the nutrient density of composite flour cookies and create novel use for sorghum, blackbean and cocoyam.

Table 1: Proximate composition (%) of sorghum, blackbean and cocoyam composite cookies

Sample ID	% Substitution WF: SF: BBF: CF	Moisture	Protein (N 6.25)	Fat	Ash	Crude Fibre	Carbohydrate
A	100: 0: 0: 0	$8.11^e \pm 0.07$	$9.07^e \pm 0.21$	$2.52^e \pm 0.05$	$3.90^e \pm 0.31$	$3.21^e \pm 0.07$	$73.19^a \pm 0.27$
B	0: 80: 15: 5	$8.27^d \pm 0.07$	$9.10^d \pm 0.23$	$3.05^d \pm 0.16$	$4.05^d \pm 0.19$	$3.55^d \pm 0.12$	$71.98^b \pm 0.69$
C	0: 70: 20: 10	$8.49^c \pm 0.42$	$10.04^c \pm 0.14$	$3.93^c \pm 0.31$	$4.59^c \pm 0.09$	$3.98^c \pm 0.19$	$68.97^c \pm 0.69$
D	0: 60: 25: 15	$9.07^b \pm 0.21$	$11.10^b \pm 0.25$	$4.19^b \pm 0.21$	$4.82^b \pm 0.05$	$4.34^b \pm 0.17$	$66.48^d \pm 0.79$
E	0: 50: 30: 20	$9.30^a \pm 0.28$	$12.10^a \pm 0.35$	$4.49^a \pm 0.27$	$5.11^a \pm 0.04$	$4.72^a \pm 0.06$	$64.80^e \pm 0.42$

Values are mean $\pm$ standard deviation of triplicate determinations. Means in the same column with different superscripts are significantly different ($p<0.05$).
WF- Wheat flour, SF- Malted sorghum flour, BBF- Malted blackbean flour, CF- Cooked cocoyam flour.

Table 2: Mineral composition (mg/100g) of sorghum, blackbean and cocoyam composite cookies

Sample ID	% Substitution WF: SF: BBF: CF	Calcium	Phosphorus	Magnesium	Potassium	Iron
A	100: 0 : 0: 0	$18.70^e \pm 0.73$	$69.50^e \pm 1.83$	$34.2^e \pm 1.08$	$33.4^e \pm 1.07$	$25.5^e \pm 1.12$
B	0: 80: 15: 15	$21.9^d \pm 0.24$	$83.6^d \pm 0; 96$	$34.7^d \pm 0.63$	$35.6^d \pm 0.89$	$27.2^d \pm 0.33$
C	0: 70: 20: 10	$24.0^c \pm 0.22$	$86.2^c \pm 0.33$	$36.0^c \pm 0.22$	$37.0^c \pm 0.18$	$28.2^c \pm 0.07$
D	0: 60: 25: 15	$27.2^b \pm 0.63$	$88.2^b \pm 0.35$	$38.1^b \pm 0.33$	$38.4^b \pm 0.61$	$29.1^b \pm 0.21$
E	0: 50: 30: 20	$28.8^a \pm 0.54$	$90.1^a \pm 0.95$	$40.1^a \pm 0.42$	$39.3^a \pm 0.48$	$30.1^a \pm 0.39$

Values are mean $\pm$ standard deviation of triplicate determinations. Means in the same column with different superscripts are significantly different ($p<0.05$).
WF- Wheat flour, SF- Malted sorghum flour, BBF- Malted blackbean flour, CF- Cooked cocoyam flour.

Table 3: Sensory properties sorghum, blackbean and cocoyam composite cookies

Sample ID	% Substitution WF: SF: BBF: CF	Taste	Flavour	Texture	Colour	Overall Acceptability
A	100: 0: 0: 0	$7.66^a \pm 1.36$	$7.56^a \pm 0.99$	$7.62^a \pm 1.08$	$7.26^a \pm 1.21$	$7.16^a \pm 1.55$
B	0: 80: 15: 15	$6.53^b \pm 1.41$	$7.40^b \pm 1.13$	$6.83^b \pm 0.10$	$7.14^b \pm 1.56$	$7.08^b \pm 1.06$
C	0: 70: 20: 10	$6.53^b \pm 1.41$	$7.33^c \pm 1.30$	$6.39^c \pm 1.33$	$6.64^c \pm 0.14$	$6.42^c \pm 1.32$
D	0: 60: 25: 15	$6.32^c \pm 1.17$	$6.86^d \pm 0.91$	$6.32^d \pm 0.98$	$6.26^d \pm 0.09$	$6.22^d \pm 0.12$
E	0: 50: 30: 20	$6.20^d \pm 0.11$	$6.26^e \pm 0.09$	$6.18^e \pm 0.86$	$6.12^e \pm 0.76$	$6.16^c \pm 0.89$

Values are mean$\pm$ standard deviation of twenty (20) semi-trained panelists. Means in the same column with different superscripts are significantly different ($p<0.05$).
WF- Wheat flour, SF- Malted sorghum flour, BBF- Malted blackbean flour, CF- Cooked cocoyam flour.

References

1. Atuonwu AC, Akobundu ENT Nutritional and sensory quality of cookies supplemented with defatted pumpkin (*Cucurbita pepo*) seed flour. Pakistan Journal of Nutrition. 2010; 9(7):672-677.
2. AOAC. Official Methods of Analysis. Association of Official Analytical Chemists. 18th edn. Washinton, DC, USA, 2006, 218-224.
3. Arshad M, Anjum F, Zahoor T. Nutritional assessment of cookies supplemented with defatted wheat germ. Food Chemistry. 2007; 102(1):123-128.
4. Audu SS, Aremu MO. Nutritional composition of raw and processed pinto bean (*Phaseolus vulgaris L.*). Journal Food Agriculture and Environment. 2011; 9:72-80.
5. Barber LI, Obinna-Echem PC. Nutrient composition, physical and sensory properties of wheat- African walnut cookies. Sky Journal of Food Science. 2017; 5(4): 024-030.
6. Berdanier CD, Zempleni J. Advanced Nutrition: Macronutrients, Micronutrients and Metabolism. CRC Press, London, 2009, 124-132.
7. Chinma CE, Gernah DI. Physico-chemical and sensory properties of cookies produced from cassava –soybean-mango composite flours. Journal of Food Technology. 2007; 5:256-26.
8. Chinma CE, Igbabul BD, Omotayo OO. Quality characteristics of cookies prepared from unripe plantain and defatted sesame flour blends. American Journal of Food Technology. 2012; 7:398-408.
9. Elemo GN, Elemo BO, Okafor JNC. Preparation and nutritional composition of complementary food formulated from germinated sorghum (*Sorghum bicolor*) and steamed cowpea (*Vigna unguiculata Walp*). American Journal of Food Technology. 2011; 6(5):413-421.
10. FAO. Roots, Tubers, Plantains and Bananas in Human Nutrition. Food and Agriculture Organization of the United Nations Rome, Italy, 1990, 98-114.
11. FAO. Maize, Rice and Wheat: Area Harvested, Production Qualityand Yield. Food and Agriculture Organization of the United Nations, Rome, Italy, 2009, 105-112.
12. FAO/WHO. Codex Alimentarius: Foods for special dietary uses (including foods for infants and children). Food and Agriculture Organization of the United Nations, World Health Organization; Rome, Italy, 1994.

13. Gary RT, Lan TO, Gerhard HF, Rosalind YW. Characterization of blackbean (*Phaseolus vulgaris L.*). Journal of Agricultural and Food Chemistry. 1997; 45(9):3395-3400.
14. Hallen E, Ibsnoglu S, Anisworth P. Effect of fermented/germinated cowpea flour addition on the rheological and baking properties of wheat flour. Food Engineering. 2004; 63(2):177-184.
15. Horsfall DM, Lucy E, Nwaojigwa SU. Chemical composition, functional and baking properties of wheat-plantain composite flours. African Journal of Food Agriculture Nutrition and Development. 2007; 7:1-23.
16. Hurs JU, Martins EM. Utilization of cereals and legumes in human nutrition. African Journal of Food Science and Technology. 2005; 1(3):22-25.
17. Igbabul BD, Amove J, Twadue L. Effect of fermentation on the proximate composition, anti-nutritional factors and functional properties of cocoyam (*Colocasia esculenta*) flour. African Journal of Food Science and Technology. 2014; 5(3):67-74.
18. Ihediohanma NC, Durunma AI, Onuegbu NC. Funtional properties and performance of Alum treated African breadfruit (*Treculia africana*) as a composite flour in cake production. Nigerian Journal of Food Science and Technology. 2009; 27(2):159-167.
19. Iwe MO. Current Trends in Sensory Evaluation of Foods. Rojoint Communication Services Ltd, Enugu, Nigeria, 2007, 132 -137.
20. JoseDe JB, Barry GS, Cheong WA. Physical characterization of stored blackbeans (*Phaseolus vulgaris L.*) Food Research International. 1999; 32(10):669-676.
21. Lutter CK ABD, Dewey KG. Proposed nutrient composition for fortified complementary foods. Journal of Nutrition. 2003; 133:30115-30205.
22. Noor AA, Mohamad NAY, Ho LH. Physico-chemical and organoleptic properties of cookies incorporated with legume flour. International Journal of Food Research. 2012; 19(4):1539-1543.
23. Nwanekezi EC, Owuamanam CI, Ihediohanma NC, Iwuno JO. Functional, particle size and sorption isotherm of cocoyam cormel flours. Journal of Nutrition. 2010; 9:973-979.
24. Okoye JI, Obi CD. Nutrient composition and sensory properties of wheat- African bread fruit composite flour cookies, Sky Journal of Food Science. 2017; 6(3):021-026.
25. Okoye JI, Ojimelukwe PC, Ukom AN. Amino acid composition and protein quality of wheat flour biscuits fortified with soybean and bambara groundnut flours. Global Journal of Science and Engineering Research. 2016; 3(4):8-19.
26. Okpala LC, Okoli EC, Udensi EA. Physico- chemical and sensory properties of cookies made from blends of fermented sorghum, germinated pigeon pea and cocoyam flour. Food Science and Nutrition. 2013; 1(1):8-14.
27. Okpala LC, Okoli EC. Nutritional evaluation of cookies produced from sorghum, pigeon pea and cocoyam blends. African Journal of Biotechnology. 2011; 10(3):43- 438.
28. Oladele AK, Osandabunsi FO, Adebowale AY. Influence of processing techniques on the nutrients and anti –nutrients of tigernut (*Cyperus esculentus*). World Journal of Dairy and Food Science. 2009; 22:88-93.
29. Onabanjo OO, Akinyemi CO, Agbon CA. Characteristics of complementary foods produced from sorghum, sesame, carrot and crayfish. Journal of Natural Sciences, Engeneering and Technolog. 2009; 8(1):71-83.
30. Onimawo IA, Akubor PI. Food Chemistry: Integrated Approach with Biochemical Background. Ambik Press Ltd, Benin City, Nigeria, 2005, 157-162.
31. Sharma HR, Chauhan GS. Effect of stabilized rice bran-fenugreek blends on the quality of breads and cookies. Journal of Food Scienceand Nutrition. 2002; 39(3):225-233.
32. Singh S, Ria CS, Saxena DC. Effect of incorporating sweet potato flour to wheat flour on the quality characteristics of cookies. African Journal of Food Science. 2008; 2:65-67.
33. Wang J, Rosell CM, Benedito the Barber C. Effect of addition of different fibres on wheat dough performance and bread quality. Food Chemistry. 2002; 79:221-226.
34. Young J. Functional bakery products: current directions and opportunities. Food Industry Journal. 2001; 55(4):136.